⑫

LEVEL II

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
LINCOLN LABORATORY

A NEW DESIGN FOR THE PROGRAMMABLE
BUTTON SYSTEM AT THE GEODSS ETS

L. E. EATON

Group 94

PROJECT REPORT ETS-39

14 MARCH 1979

LEXINGTON   MASSACHUSETTS

ABSTRACT

Two new design approaches are presented for upgrading the programmable button interface at the GEODSS ETS. These designs make use of the Motorola microprocessors. The design simplifies the logic, standardizes the interface to the host computer and provides increased versatility with the microprocessor software.

This document assumes the reader is familiar with the GEODSS Experimental Test System (ETS) and its basic operational configuration.

iii

CONTENTS

I.   INTRODUCTION

The main operator/computer interaction now employed at the GEODSS ETS[*] is through a button/indicator system.   The control console can have up to 256 button-activated switches and lamps for individually backlighting each switch.   The buttons are assigned various functions which the operator may activate by pressing the appropriate switch; the software senses a switch closure and activates the particular response assigned to that switch.

Because of recent increases in the state of the art of integrated circuit (IC) manufacturing the programmable button module design now used at the GEODSS ETS can be greatly simplified and improved.   This report presents two new design approaches based upon the use of a microprocessor. The microprocessor allows one to use a total of ten ICs compared to the present ETS design with 15 logic cards, each having 60 ICs.   All control is incorporated in the software so that modification of functions, etc., become much easier to implement.

The microprocessor system used in this design is the Motorola M6800 family of ICs.   The GEODSS ETS is presently

---

[*] This document assumes the reader is familiar with the GEODSS Experimental Test System (ETS) and its basic operational configuration.   For a more detailed description, refer to ETS-26, "GEODSS ETS Computer/Hardware Configuration," November 28, 1977 by L. E. Eaton.

using the Motorola Microprocessor in the telescope control
and other hardware, and our familiarity with this microprocessor
and its development system has prompted us to use it here;
however, the design could be transferred to any other
similar microprocessor system.

II. PRESENT ETS BUTTONS DESIGN

The present equipment at the ETS allows the switch/ indicator system to be used as "programmable buttons". Mechanically, each switch is a momentary-contact switch, assigned a unique identification number; each closure is reported to the host computer (the Modcomp) and the backlighting for each switch is independently controlled by the Modcomp. The main design feature is that the sensing of the switch closures and the backlighting control of each switch are independent hardware functions so that each switch can be defined, by the software, to be a momentary switch, a latching switch, just an indicator, etc.

Most switches at the ETS are defined as latching switches. In this mode, the operator presses the button, the software senses the closure, and then changes the state of the back-lighting. Figure 1 is a block diagram of the present design.

Each time a switch closure occurs the logic is cycled to sample each switch and the number of the closed switch is loaded into a scratch pad memory (SPM), accessible to the Modcomp and read at a cyclic rate which, in the case of the ETS, is 10 hertz. The Modcomp keeps track of the current state of all switches; and at initialization time all switches are considered to be off. Then as indication of a switch closure is received by the computer the state of that switch

3

ETS-39(1)

MOD COMP INPUT WORD

8 BIT SW CODE

MOD COMP COMPUTER

256 MOMENTARY BUTTONS

256

LOGIC FOR SAMPLING SWITCH CLOSURES

8

LOGIC FOR LIGHTING OR EXTINGUISHING THE LAMPS

9

LAMP ASSOCIATED WITH EACH BUTTON

8 BIT LAMP CODE

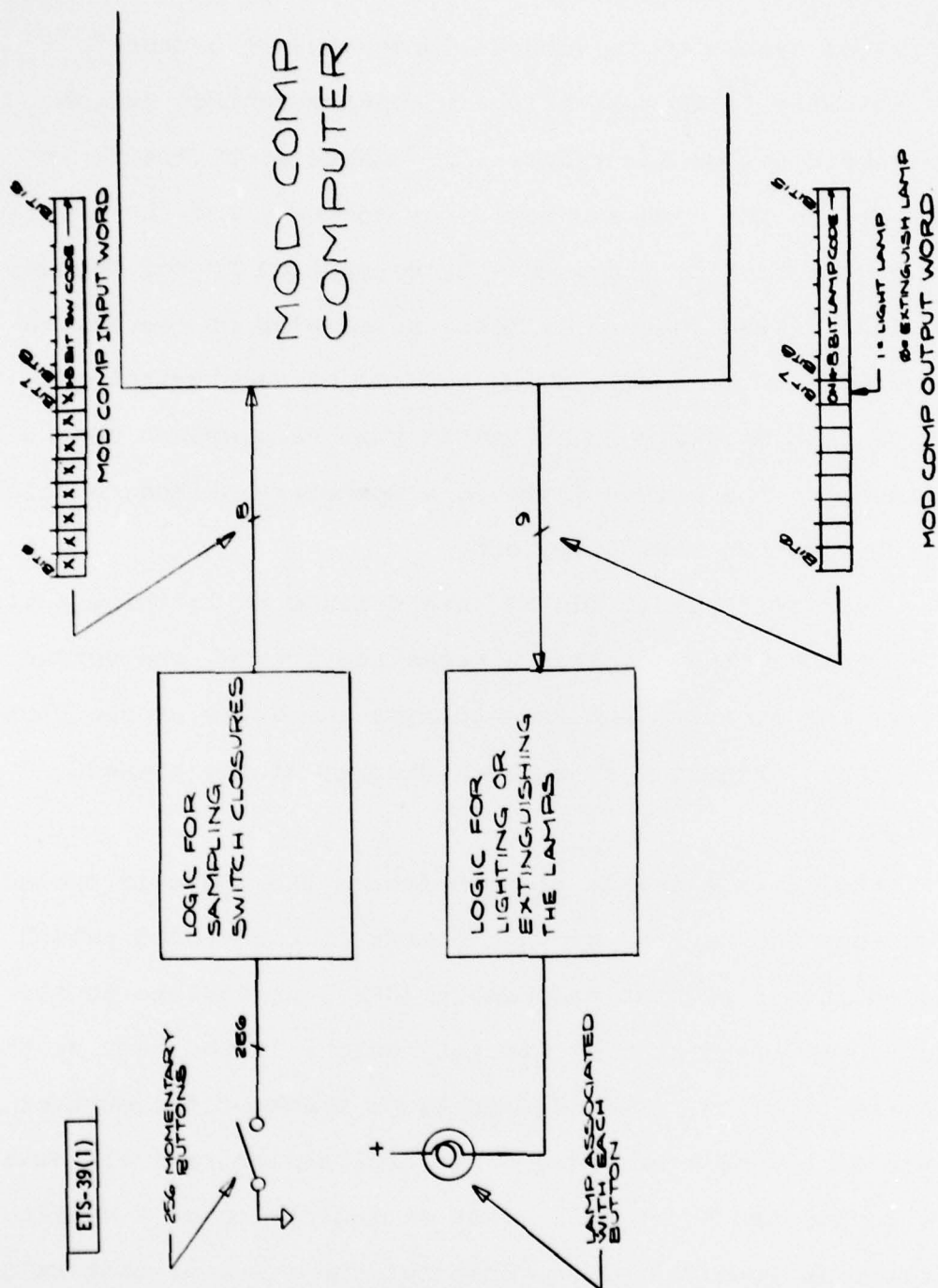1 = LIGHT LAMP
Ø = EXTINGUISH LAMP

MOD COMP OUTPUT WORD

Fig.1.   Present GEODSS ETS button design.

can be toggled. For example, a switch has been defined as a latching type switch, it is backlighted by the Modcomp on the first closure and is extinguished by the next closure, and so on.

If a button is to be defined only as a lamp then it may be used as an indicator to the operator. In the case of the ETS, one such use of a button is to indicate that the telescope elevation is too low. The switch closure associated with this button is ignored by the software because it has been defined only as an indicator. When the telescope returns to a safe elevation, the lamp is extinguished by the software.

Buttons at the ETS are physically configured in modules of 32 momentary switches with 32 lamps behind each switch, and up to 8 of these modules can be accommodated by the computer, although we are only using 3 modules per console at present.

5

III. TWO NEW DESIGNS

The new button system will maintain the following features of the original design.

1. Switch closures reported to the host computer.

2. Backlighting of buttons based on commands from the host computer.

3. The buttons configured in Modules of 32.

The following improved features are sought.

1. Logic design simplified to decrease amount of cabling and ICs.

2. Standardize the interface to the host computer to one similar to those used on other computer systems.

A. DESIGN 1 - USING THE M6800

Figure 2 shows a first design using the Motorola M6800 microprocessor and the associated family of interfacing ICs now available. Many software development tools associated with the 6800 are also available. Each one of the blocks in Figure 2 represents an LSI chip available from Motorola that is compatible with the 6800 microprocessor. The ICs in Figure 2 are as follows:

CPU - Central Processing Unit: This is the main micro-processor that will be executing the users program.

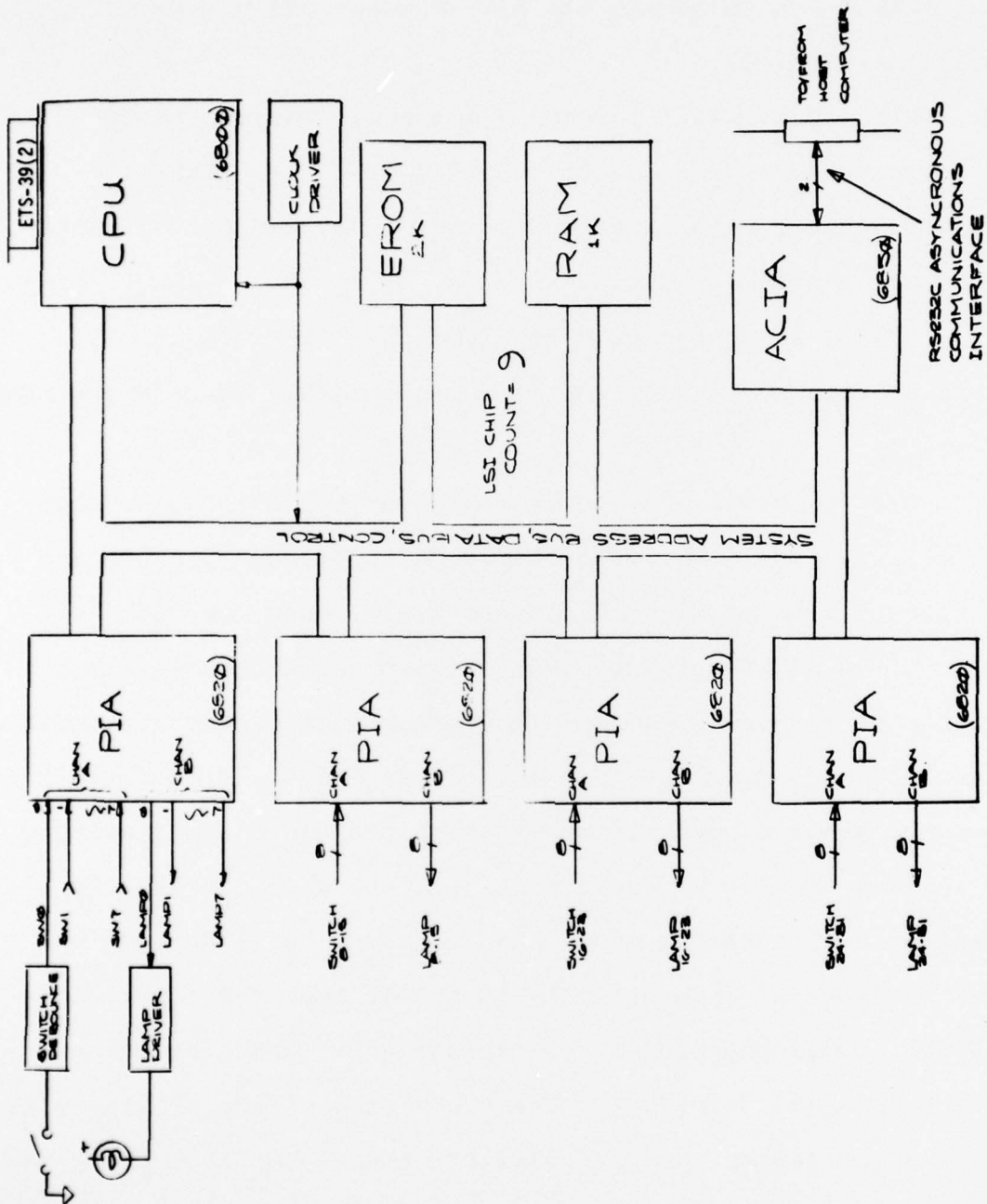CLK - This chip generates the clock needed to drive the CPU.

6

Fig.2. Button configuration with the M6800.

7

EROM - Erasable Read Only Memory: Provides storage for the user control program.

RAM - Random Access Memory: Scratch pad memory for temporary storage.

PIA - Peripheral Interface Adapter: This IC is Motorola's 8-bit parallel interface to the CPU's I/O bus. Data are transferred to or from either channel A or B under software control, a byte at a time.

ACIA - Asynchronous Communications Interface Adapter: This chip provides an RS232C serial communications interface to the CPU.

A program will be required for the microprocessor that will do two basic things: one, monitor switch closures and send notification of each closure to the host computer via the RS232C interface; two, receive backlighting commands from the host computer and light or extinguish the appropriate lamp. The program cycle is an endless loop, periodically reading the state of each switch through the PIA. Eight switches will be connected to one PIA channel and when a switch is closed one bit of the word in that channel will be set to a 1. The software will decode the bit number into the appropriate switch number and send this information to the host computer via the RS232C interface. The cycle time of the program will have to be faster than it takes for the operator to press the same switch twice; probably 20 to 50 hertz. The software will

8

also monitor the ACIA for backlighting information from the host computer. The other channel of the PIA will have 8 lamps tied to it, a 1 being the indication to light the lamp and a $\emptyset$ to extinguish it.

Both of the design criteria have been met; the required ICs are only 9 LSI chips; and these are readily available at a cost on the order of $10.00 apiece; (2) the standardized RS232C interface is available on all computers and is one of the simplest forms of 2 wire communication.

B.   DESIGN 2 - USING THE M6801

In the second quarter of 1979, Motorola will be making available the M6801 microprocessor which will have the same instruction set as the 6800 and which will be a complete computer system on a single chip.   Figure 3 shows a block diagram of the 6801 as well as its use as the centerpiece of a button handler.

The 6801 is a self contained processor, with its own RAM, ROM, I/O PORTS, CPU, CLOCK and an Asynchronous Communications Port.

24 I/O lines similar to the PIA chip of the 6800 design are incorporated in the 6801. 8 of these lines will be used to monitor switch closures, another 8 lines will be used to control the lamps, and the last 8 lines will be used to communicate with the master 6801.
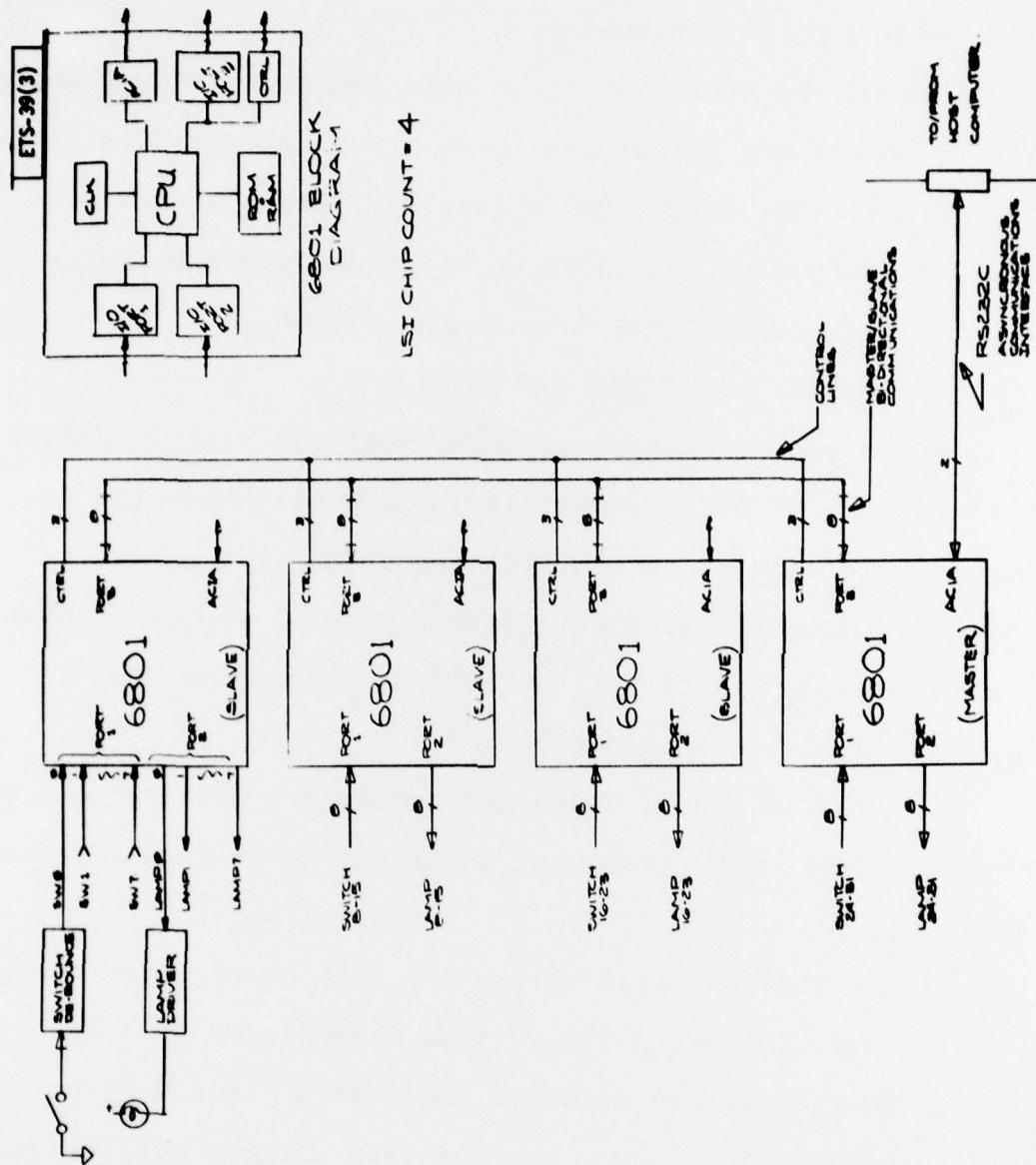
Fig. 3. Block diagram of switch design using M6801.

As the figure indicates, each 6801 will have responsibility for monitoring 8 switches and the lighting for 8 lamps. One of the 6801's will be dubbed the master and will have the added responsibility of collecting all switch closure information from the other three 6801's and passing that on to the host computer via the RS232C interface. The master 6801 will also receive backlighting commands from the host computer and will pass those on to the slave 6801s.

This design is simpler, with a smaller IC count than the first design, but involves additional complications in the multiprocessing scheme, however, the function of each 6801 is fairly simple. These ICs presently cost about $70.00 for the EROM version, but as this is the initial release the price will undoubtedly come down.

11

IV. CONCLUSION

The use of a microprocessor as the basis for the button design has many advantages, the most important being the versatility achieved by allowing software to control the system. Further, using a microprocessor simplifies the design and makes possible a standardized communications interface to the host computer. The microprocessor software can be designed to report switch closures to the host computer and receive backlighting information from the host computer. Another level of sophistication could be added to the design by allowing the host computer to tell the microprocessor, via the RS232C interface, the definition of each switch at initialization time. The definitions would allow switches to be defined as momentary, latch type, indicators only, etc., and the microprocessor could limit communications with the host computer during operations because it could then be able to handle the backlighting by itself.

One of these designs will be incorporated in the Programmable Video Digitization System (PVDS) currently being built and this prototype will be used at the ETS with an RS232C interface to the Modcomp computer.

12

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ESD-TR-79-42	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* A New Design for the Programmable Button System at the GEODSS ETS		5. TYPE OF REPORT & PERIOD COVERED Project Report
		6. PERFORMING ORG. REPORT NUMBER Project Report ETS-39
7. AUTHOR*(s)* Lawrie E. Eaton		8. CONTRACT OR GRANT NUMBER*(s)* F19628-78-C-0002
9. PERFORMING ORGANIZATION NAME AND ADDRESS Lincoln Laboratory, M.I.T. P.O. Box 73 Lexington, MA 02173		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Program Element No. 63428F Project No. 2128
11. CONTROLLING OFFICE NAME AND ADDRESS Air Force Systems Command, USAF Andrews AFB Washington, DC 20331		12. REPORT DATE 14 March 1979
		13. NUMBER OF PAGES 20
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)* Electronic Systems Division Hanscom AFB Bedford, MA 01731		15. SECURITY CLASS. *(of this report)* Unclassified
		15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

None

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

GEODSS
ETS
design

programmable button system
microprocessors

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Two new design approaches are presented for upgrading the programmable button interface at the GEODSS ETS. These designs make use of the Motorola microprocessors. The design simplifies the logic, standardizes the interface to the host computer and provides increased versatility with the microprocessor software.

This document assumes the reader is familiar with the GEODSS Experimental Test System (ETS) and its basic operational configuration.

DD FORM
1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

207 650